REMARKS/ARGUMENTS

Claims 1-5, 7-24, and 28-30 are pending. No claim has been amended, canceled, or added.

Claims 1, 2, 4-5, 8-11, and 15-16 were rejected under 35 U.S.C. § 102(b) as being anticipated by Hshieh et al. (US 6,629,543). Applicants traverse the rejection.

The claimed embodiment of claim 1 is directed to increasing the breakdown voltage (BV) of a power device. One way to achieve this result is by reducing the slope or curvature of equi-potential lines defined within the power device (see paragraph 34). This is obtained by providing the first portion of the gate within a trench and reducing the profile difference between the gate and the first and second doped regions. This reduces the curvature of the equi-potential lines 288 and 298 (Figs. 4 and 5), thereby reducing the electric field in the vicinity of the p/n junction which increases the breakdown voltage (see paragraph 40). The claimed embodiment provides relatively flatter equi-potential lines since the lower portion of the gate is brought closer to the lower portion of the P-well 286, so that together they would present a more evenly-shaped lower surface (compare with the lower surfaces of the devices illustrated in Figs. 1-3 of the present application).

One way to increase the breakdown voltage is to provide a trench (wherein a gate is formed) that does not extend below the first doped region. This results in flatter equi-potential lines. Claim 1 recites, "a gate provided between the first and second source regions, the gate including a first portion extending laterally within the trench, wherein a depth of the trench is no more than a depth of the first doped region, wherein the gate has a lateral extension and a vertical extension, the lateral extension being substantially greater than the vertical extension to reduce the curvature of equi-potential lines that are defined below the gate and the first and second dope regions." Hshieh, however, illustrate trenches 26A and 26B that extend below "the P doped body region 18."

Another way to increase the breakdown voltage is to provide a gate with a lateral extension that is substantially greater than its vertical extension. Claim 1 recites, "wherein the gate has a lateral extension and a vertical extension, the lateral extension being substantially

substantially greater than the vertical extension to reduce the curvature of equi-potential lines that are defined below the gate and the first and second dope regions." Hsieh discloses a trench having the depth of 1.7 microns and the width of 1-2 microns. Hshieh accordingly does not disclose or suggest the features above relating to reducing the curvature of the equi-potential lines and increasing the breakdown voltage. Rather Hshieh is directed to reducing the drain-source on resistance of a trenched DMOS transistor and achieving a high cell density (col. 1, lines 46-50). Claim 1 is allowable at least for the reasons set forth above.

Claim 7 recites, "wherein a ratio of a length of the first portion of the gate to the depth of the trench is at least 2.5:1." That is, the gate is provided with a lateral extension that is substantially greater than its vertical extension, thereby increasing the breakdown voltage. Accordingly, the recited feature is not a mere routine optimization, as the Examiner asserted. Claim 7 is allowable for this additional reason.

Claim 16 recites, "a gate provided adjacent the first source region, the gate including a first portion provided within the trench, wherein a depth of the trench is no more than a depth of the first doped region, the gate having a lateral extension and a vertical extension, wherein the lateral extension of the gate is substantially greater than the vertical extension of the gate." Hshieh does not disclose the above recited features. Claim 16 is allowable.

Claims 19, 20, and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Hshieh. Applicants traverse the rejection.

Claim 19 recites, "a gate provided adjacent the source region, the gate including a first portion provided within the trench and a second portion provide outside of the trench, the first portion having a length that is greater than the first depth of the trench, wherein the first portion includes a lateral extension and that is parallel to the first and second surface of the substrate, wherein the lateral extension of the first portion is at least 2.5 times greater than the first depth of the trench." Hshieh does not disclose the above recited features. Claim 19 is allowable.

Claims 22 recites, "forming a shallow trench on a substrate having a first surface and a second surface, the shallow trench having a first depth and a width, the width of the

shallow trench being greater than the first depth of the shallow trench; forming a doped region provided proximate the first surface of the substrate and having a second depth; forming a source region provided within the doped region and proximate the first surface; and forming a gate structure provided adjacent the source region, the gate structure including a first portion provided within the shallow trench and a second portion provide outside of the trench, wherein the first portion includes a lateral extension and that is parallel to the first and second surface of the substrate, wherein the lateral extension of the first portion is at least 2.5 times greater than the first depth of the shallow trench." Hshieh does not disclose the above recited features. Claim 22 is allowable.

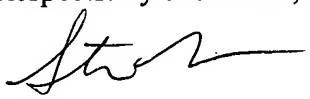
Applicants thank the Examiner for indicating that claims 23 and 24 include allowable subject matters and allowing claims 28-30.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance and an action to that end is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,



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